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Title

STEPS REPRESENTING TWO DIMENSIONAL AND THREE DIMENSIONAL FACE RECOGNITION PROCESS

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Abstract:

Facial recognition systems are computer-based security systems that are able to automatically detect and identify human faces. These systems depend on a recognition algorithm, such as eigenface or the hidden Markov model. The first step for a facial recognition system is to recognize a human face and extract it from the rest of the scene. Next, the system measures nodal points on the face, such as the distance between the eyes, the shape of the cheekbones and other distinguishable features. These nodal points are then compared to the nodal points computed from a database of pictures in order to find a match. Obviously, such a system is limited based on the angle of the face captured and the lighting conditions present.

Keywords: Face recognition, two dimension recognition system and three dimension recognition system.

Introduction: An important difference with other biometric solutions is that faces can be captured from some distance away, with for example surveillance cameras. Therefore face recognition can be applied without the subject knowing that he is being observed. This makes face recognition suitable for finding missing children or tracking down fugitive criminals using surveillance cameras. [1, 2]

Independent of the solution vendor, face recognition is accomplished as follows: A digital camera acquires an image of the face. Software locates the face in the image; this is also called **face detection**. Face detection is one of the more difficult steps in face recognition, especially when using surveillance cameras for scanning an entire crowd of people. When a face has been selected in the image, the software analyzes the spatial geometry. The techniques used to extract identifying features of a face are vendor dependent. In general the software generates a template, this is a reduced set of data which uniquely identifies an individual based on the features of his face [3, 4,].The generated template is then compared with a set of known templates in a database (identification) or with one specific template (authentication) [5, 6].The software generates a score which indicates how well two templates match**.** It depends on the software how high a score must be for two templates to be considered as matching, for example an authentication application requires low FAR and thus the score must be high enough before templates can be declared as matching. In a surveillance application however you would not want to miss out on any fugitive criminals thus requiring a low FRR, so you would set a lower matching score and security agents will sort out the false positives.

Types of facial recognition system

(i) **Two-Dimensional Facial Recognition System**:

Long before the advent of sophisticated computing technologies and image enhancement software, the technology involving two-dimensional facial recognition system had evolved. But this technology didn't last for long as it had some big drawbacks. The most important drawback being the fact that the person to be identified must be facing the camera at no more than 35 degrees for accurate identification to be possible. Light differences and facial expressions also contributed to low accuracy in recognition of such system.

(ii) Three-Dimensional Facial Recognition System:

The two dimensional facial recognition system soon became a thing of the past. And it made a way for the three dimensional facial recognition system. This system was much more accurate and stable than its predecessors.[7,8] Unlike the two dimensional facial recognition systems, this system made use of distinct features in a human face and used them as nodes to create a face print of the person. The three dimensional facial recognition system recognizes a face even when it is turned 90 degrees away from the camera. Moreover, it remains unaffected by the differences in lighting and facial expressions of the subject.

The FaceRec application studied here can be viewed as a pipeline of three major functional components. A flesh tone detector is used to isolate areas of a frame where a face is likely to be present. The next stage is a face detector that determines whether a face is present or not in each area of interest. The final phase is a face recognizer. Each of these components is based on well known algorithms that have been adapted or reimplemented to fit into a unified framework. Some algorithmic optimization and restructuring has been done to suit benchmarking purposes, but the basic approach has been developed by other researchers [9, 10].

Interestingly the face recognition system, when viewed from a structural perspective comprises a series of increasingly discriminating filters. Early stages of the sequence must inherently filter the entire image. As the process proceeds downstream, each stage needs to examine less image data since previous stages have eliminated certain areas from the probable candidate list. The result is an interesting balance of simple algorithms that analyze lots of data early in the sequence and more sophisticated algorithms that only need to analyze limited amounts of data late in the process. The result is a structure that is amenable for implementation as an embedded system. [11, 12]

Figure .1 shows the major steps in face recognition. The input is a low-resolution video stream such as 320x200 pixel images at 10 frames per second. The stream is processed one frame at a time, and sufficient state is maintained to perform history sensitive tasks like motion tracking. The process is essentially a pipeline of filters that reduce the data and attach attributes to frames for the use of downstream components. Typically each filter is invoked at the frame rate. This underlines the soft real-time nature of this application. Additional data is required since filters may access large databases or internal tables. These additional data streams add to the aggregate bandwidth requirement of the system. The periodic nature of the application domain often makes it possible to easily estimate the worst case requirements.

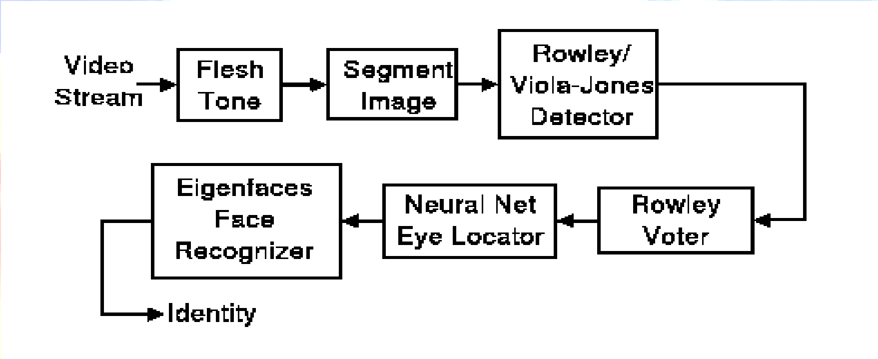


Figure .1: Algorithmic Stages of a Face Recognizer

Object recognition typically proceeds in two steps: object detection and the actual object identification. Most approaches to object identification require a clearly marked area, normalized to a particular size, and the location of key features. Object detectors find the area where the desired feature is likely to reside, scale the area to meet the normalization requirement, and then create a location and boundary description for that area. False positives and negatives occur, but the algorithms try and minimize their occurrence.

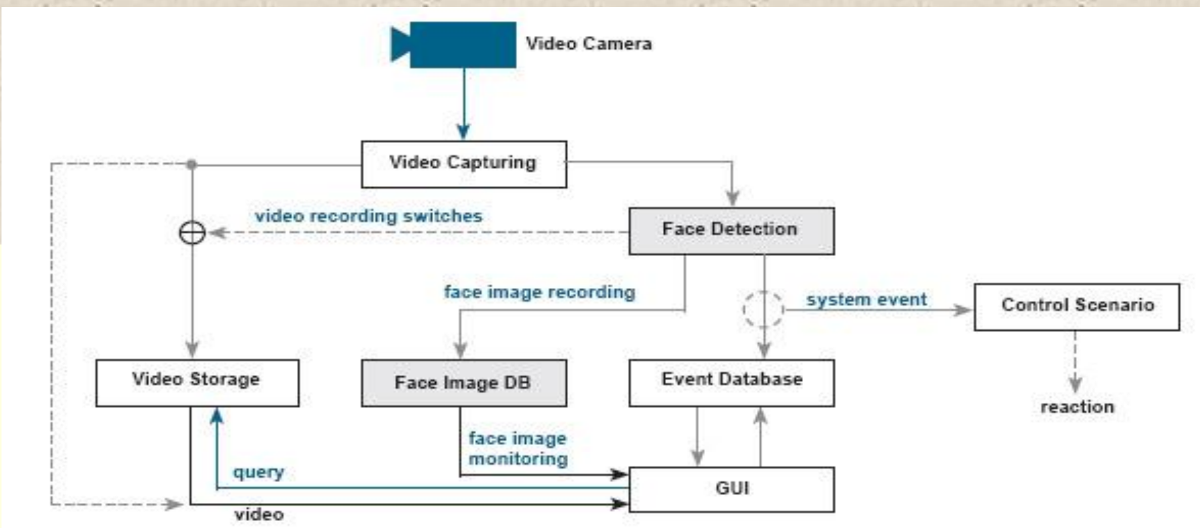
Object detectors also often work at a fixed scale. The detector is swept across the image recording all positions at which detection was reported. The image is then subsampled or scaled down by a small factor (typically 0.8), and the process is repeated until the frame is below the size of the detector. A decision procedure is then applied to all the predicted hits to decide which ones are the most likely. Detectors often have much lower compute cost per sub window than their corresponding identifying routines. Since they are swept across the entire image, a significant portion of the application's execution time might be spent in the detector. In contrast, even though identifying filters are more compute intensive, they are applied only to the high probability regions of the frame, so their contribution to the overall execution time might be low. Though object detectors are less compute intensive, they are much more difficult to design due to their generality. For example a face identifier chooses from one of N known faces, but a face detector has to distinguish between the infinite sets of faces and nonfaces.

Since detection is time consuming, it is common to structure an object detector as a cascade of filters with cheaper heuristics upstream identifying potential regions for more expensive heuristics downstream. An extreme case of this is the Viola/Jones method, which trains a sequence of about 200 increasingly discriminate filters. A more common approach when dealing with faces and gestures is to identify the flesh colored regions of an image and apply a more sophisticated detector to those regions. [13]

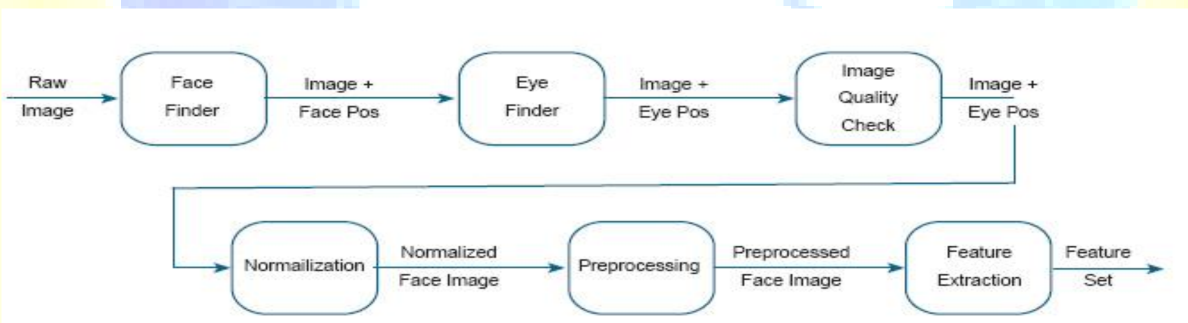
The identifier receives candidate regions from the detector along with other information like probability, scale and feature locations. It typically employs some type of distance metric from known references to provide a positive identification. In the face recognizer, the first level of detection is provided by flesh toning which is followed by an image segmenting algorithm. These are followed in turn by a more complex detector, voting for high probability regions, an eye locater and finally a face identifier.

The reliability of the system, the high percentage of **face capture and recognition** accuracy and speed of identification are ensured by use by the specially developed algorithms. Face Capture can be used at airports, banks, casinos, public buildings, subways, factories, schools or in any other location where it makes sense to record the faces of visitors, with facilities for integration into existing VMS applications. The Face Capture & Recognition GUI is very simple such that any operator can use all of its functions with just a minimal amount of training. The system is highly flexible, allowing images to be digitized and recorded in either color or monochrome with a storage capacity typically exceeding 12 months of facial data recording. The Face Capture &

Recognition screen simultaneously shows the live camera shot and the latest sequence of captured images.



The following steps, all automated by the software, and completed in milliseconds in the background, are critical in the successful execution of the SecurOS Face Capture & Recognition module.



Conclusion:

Face recognition systems used today work very well under constrained conditions, although all systems work much better with frontal mug-shot images and constant lighting. All current face recognition algorithms fail under the vastly varying conditions under which humans need to and are able to identify other people. Next generation person recognition systems will need to recognize people in real-time and in much less constrained situations.

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